Abstract #481, 224th ECS Meeting, © 2013 The Electrochemical Society

Investigation of Performance and Stability of Li-O_2 Batteries in terms of Electrolyte and Catalyst Material

Ramchandra S. Kalubarme and Chan-Jin Park *

Department of Materials Science & Engineering, Chonnam National University, 77, Yongbong-ro, Buk-gu, Gwangju – 500757. Republic of Korea

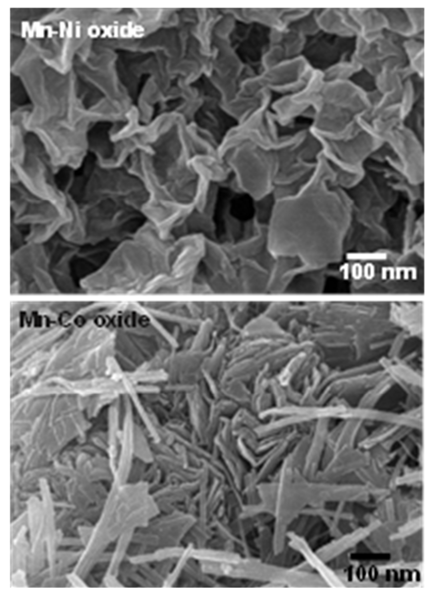
* parkcj@chonnam.ac.kr

While metal-air batteries based on zinc, magnesium and aluminum anodes have been well developed, the development of lithium-air batteries had remained elusive until the breakthrough study by Abraham et.al [1]. The attractiveness of Li-air batteries compared to other common battery systems is due to the promise of greatly improved energies and capacities of Li-air batteries. A typical Li-air battery cell consists of a Li foil as the anode and an air electrode as the cathode with the electrolyte in between to allow Li ions to transfer. The performance of the Li-air batteries strongly depend on the electrolyte employed viz. non-aqueous or aqueous or hybrid. However, the non-aqueous solvents are not stable in the operating environment of Li-air cell. The highly reactive reduced oxygen species (O_2^-) produced during the oxygen reduction reaction reacts with solvent and decompose it during charge-discharge process. Hence, there is need to develop highly stable new electrolyte (solvent) to make Li-air batteries rechargeable.

Apart from the electrolytes, there are other materials and environmental parameters that influence the electrochemical performance of Li-air batteries, e.g. the use of binders and catalysts, different structures of cathode materials and presence of moisture. Out of these factors, catalyst are the single most important material that influences the charge/discharge process in Li-air batteries. From a rational design point of view, an ideal cathode catalyst in the Li-O_2 battery should have highly active catalytic centers, which is densely distributed over the carbon support surface, by maintaining minimum separation between individual sites to achieve maximum interaction with the solid precipitates such as a Li_2O_2. The active sites should also be easily accessible to the electrons necessary to complete the electrochemical reactions.

In this work, we have carried out experimental study of the stability during discharge of electrolytes based on sulfolane and sulfolane-glyme mixture in lithium-oxygen batteries. Sulfolane is a universal dipolar solvent and having the oxidation states of sulfoxide. Besides high solubility, low toxicity, superior safety as well as sufficient ion dynamics, sulfolane also has lower volatility and higher resistance to electrochemical oxidation. The experimental studies are based on X-ray photoelectron spectroscopy (XPS) and Fourier transform infrared (FTIR) studies of charge and discharge products.

Furthermore, novel and simple chemical technique was used to prepare the mixed metal oxides composites of Mn, Co and Ni. Various ratios of the composite materials were prepared by merely adjusting the concentration of the constituent elements in the experimental solutions. The morphologies like flakes, nanorods and spheres were obtained by engineering the experimental parameters like temperature and time. The specific capacities and the cycle life of the Li-oxygen cell containing these mixed oxide catalyst were investigated and results were presented.



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